



**Whatcom County Washington Manure Application Study - Ground-Water
Monitoring and Lysimeter Use Questions**

Curt Black to: jrnimmo

Bcc: Sheila Fleming

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● **John Nimmo, Physicist, Project Chief**

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John,

Thank you for the chance to talk today. I appreciate your ideas and hope you might point me toward some literature which highlights some of the limitations of lysimeter use in quantifying fluxes of nutrients beyond the root zone in agricultural fields underlain by shallow ground water. EPA has granted a local Conservation District a significant amount of money to test different application rates for their potential to impact ground-water nutrient concentrations. After that grant was awarded, I was asked to evaluate the Quality Assurance Project Plan for the project. I didn't feel the QAPP was approvable because it failed to collect measurements of sufficient number or quality from the resource we were seeking to protect - that is, the ground water. The District instead proposed to solely rely on an array of lysimeters to quantify the flux of nutrients out of the root zone and to the underlying ground water. I would prefer we directly measure nutrient concentrations as they arrive at the uppermost saturated zone beneath the fields receiving manure treatments.

Specifically, the District has proposed a lysimeter installation consisting of paired suction lysimeters and pan lysimeters at 6-inches, 12-inches and 24-inches. There would also be soil moisture blocks at each depth. Specifically they have proposed an, "...Improved zero-tension gravitational pan lysimeter" and a "Model 1900L Soil Moisture Equipment, Corp" device. I am concerned that any flux estimation based on measurements collected from these lysimeters will under estimate the true flux due to preferential flow which I expect from the general physics of unsaturated zone flow. The original proposal included one installation as described above for each 10 acre test plot. I counter proposed seven such installations to attempt to get past the spatial variability and preferential flow path uncertainty, but I know of no statistical tool to address quantifying the uncertainty - is seven enough? How do you determine the confidence you should have in your characterization of potential preferential flow paths in the unsaturated zone?

What I suspect is that I can't really have any confidence in the lysimeter data and should instead look at the ground water. It appears we will be doing both, so we have the opportunity to possibly relate the measured flux from the lysimeters to the flux in ground water.

Please point me toward some of the literature which might help me convince the District that examination of the ground water is appropriate. If any of your studies showed failure to adequately capture preferential flow paths or meaningful flux data I would appreciate seeing them.

If I may provide any additional background information for these questions or any clarification of the scope or approach, please contact me at 206 755-4541c.

Thank you for your help with these questions,

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